Chemistry

I. Elements and Compounds

A. Definitions

Chemistry – the study of matter, its properties, and its changes or transformations.

Matter – anything that has mass and takes up space

B. Classification of Matter

Pure Substance – all particles that make up the substance are the same

Elements – pure substances that cannot be broken down into simpler substances

Compounds – pure substances that contain two or more different elements in fixed proportions

C. Properties of Matter

Physical Property – a characteristic of a substance

- Melting point/Boiling Point
- Color
- Odor
- Does not change chemical properties

Physical Change – a change in the size or form of a substance, which does not change the chemical properties

- Freezing - liquid to solid
- Melting – solid to liquid
- Boiling – liquid to gas
- Condensation – gas to liquid
- Sublimation – solid to gas

Chemical Property – a characteristic behavior that occurs when a substance changes to a new substance

Chemical Change

- New substance is formed
- Gas evolved
- Color change
- Difficult to reverse
- Heat or light given off
- Solid formed

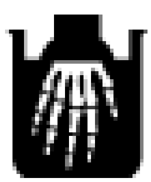
D. <u>Hazardous Household Chemicals</u>

Warning Labels

Toxic — substances that even in small quantities may poison, cause injury or death when swallowed, absorbed through the skin or inhaled into the lungs.

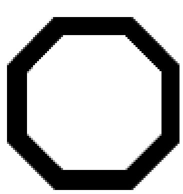
Flammable — substances, usually liquids, that can readily ignite (burn in air) in a wide range of temperature conditions.

Corrosive — substances or vapors that can deteriorate or eat away the surface of another material.

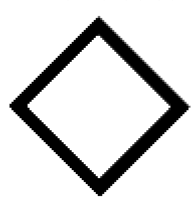


Reactive/Explosive — substances that can react with air, water or another substance to produce toxic vapors or explode.

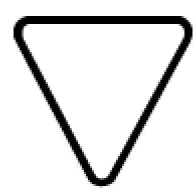
Degree of Danger — Combined with the 3 symbols below; the classification images above show the type and extent to which a substance can be harmful.



Danger

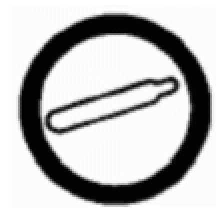


Warning



Caution

CLASS A – COMPRESSED GASES



CLASS B - FLAMMABLE AND COMBUSTIBLE MATERIALS

Division 1 - Flammable Gas

Division 2 - Flammable Liquid

Division 3 - Combustible Liquid

Division 4 - Flammable Solid

Division 5 - Flammable Aerosol

Division 6 - Reactive Flammable Material

CLASS C - OXIDIZING MATERIALS

CLASS D - POISONOUS AND INFECTIOUS MATERIALS

Division 1

Materials Causing Immediate and Serious Toxic Effects

Subdivision A - Very Toxic Materials
Subdivision B - Toxic Materials

Division 2

Materials Causing Other Toxic Effects

\Subdivision A - Very Toxic Materials
Subdivision B - Toxic Materials

Division 3

Biohazardous Infectious Materials

CLASS E - CORROSIVE MATERIALS

CLASS F - DANGEROUSLY REACTIVE MATERIALS

Assignment P. 165 - 175 # 1 – 8
P. 176 – 179 a - j

E. Periodic Table

Periodic Table – a structured arrangement of elements that helps us to explain and predict physical and chemical properties.

Chemical Families – groups of elements in the same vertical column or “group”

Examples:

Group 1 - Alkali Metals

Group 2 – Alkaline Earth Metals

Transition Metals

Nonmetals

Metalliods – B, Si, Ge, As, Sb, Te, Po.

Group 7 – Halogens

Group 8 – Noble Gases

The rows of the Period Table are called the “periods”.

F. Elements and Atomic Structure

Bohr-Rutherford Model – Diagram Pg. 185 – 186 Nelson

Proton – positive charge located in the nucleus

Neutrons – neutral charge located in the nucleus

Electrons – negatively charged located in the electron cloud in orbits or shells

Atoms have an equal number of protons and electrons so that they are electronically neutral.

G. Bohr Diagrams

Each shell or orbit can hold only a certain number of electrons.

First orbit – 2 electrons
Second orbit - 8 electrons
Third orbit – 8 electrons

Examples:

Lithium

Fluorine

Sulfur

Calcium

Valence shell – the outermost orbit in an atom

H. Ions

When elements form compounds changes occur in the arrangements of their electrons

Elements will gain or lose electron from its valence shell to attain the same configuration as the noble gases.

When the atoms gain or lose electrons they become ions.

If an element loses electrons it becomes positively charge and is called a **cation**

Example – Lithium Li^{+}

If an element gains electrons it becomes negatively charged and is called an **anion**

Example – Fluorine F^{-}

I. <u>Compounds</u>

Ionic compounds – formed by the transfer of electrons from one metal atom to a nonmetal atom

Molecular compounds – formed when nonmetals share electrons with other nonmetals

Assignment P. 184 - 187 #1 - 8
Assignment P. 188 - 189 #1 - 4

K. <u>Writing Ionic Compound Formulas</u>

Common Ions HAND-OUT

<u>Electronic Structure/Bohr Diagrams</u> can be used to predict the ionic charges of elements.

Ionic Charges may also be called the **<u>valence</u>** or combining capacity.

Metals and Nonmetals combine to form ionic compounds by transferring electrons

Remember metals are on the left side of the staircase and nonmetals are on the right.

Metals tend to lose electron and nonmetals tend to gain electrons the result of the bonding between the two is a neutral compound.

Example: $AlCl_3$ with Bohr Diagrams

Formulas for Simple Binary Ionic Compounds

Binary – two elements

Ionic compounds are written with the metal first and the nonmetal second the name of the nonmetal is altered by dropping the ending and adding –ide

Example:

Oxygen is oxide
Sulfur is sulfide

Lithium oxide is Li and O and charges from the Periodic Table are 1+ and 2-

Rules for Writing the Formulas for Ionic Compounds

Rule 1: Write the symbols of the elements with the metal first.

Rule 2: Write the ionic charges above the symbols

Rule 3: Choose the number of ions needed to balance the charge

Rule 4: Write the formula using subscripts (lowest terms)

Example:

Calcium Iodide

Aluminum Sulfide

L. Naming Simple Binary Ionic Compounds

When naming simple binary ionic compounds you must name the metal first and than the nonmetal. Remember to drop the ending of the nonmetal and add –ide

Example:

NaCl

Ca_3N_2

Atoms with More than One Charge

Some special cations have the ability to attain more than one charge. When these are present you must name them with their charge in brackets. It is important to attain the charge of the cation from the known charge of the anion.

Example:

$CuCl_2$

CuCl

Assignment P. 192 - 195 #1 – 10
Blackline Master 5.8
Hand-outs

M. Polyatomic Compounds

Polyatomic ions – groups of atoms that tend to stay together and carry an overall ionic charge.

Writing Formulas for Polyatomic Compounds

Follow the same general rules used for binary ionic compounds BUT polyatomic ions can never be reduced from their original form and you must use brackets when there is more than one.
Example:

Sodium sulfate

Calcium carbonate

Magnesium hydroxide

Naming Polyatomic Compounds

When naming polyatomic compounds name the cation first followed by the name of the anion names DO NOT change.

Assignment P. 196 - 198 #1 – 7
Blackline Master 5.9
Hand-outs

N. Nomenclature of Acids and Bases

Binary Acid Nomenclature

- A binary acid is the combination of hydrogen (+) and an anion (-) in aqueous (dissolved) conditions
- The form of the name is hydro(root)ic acid
  - $HF_{(aq)}$
  - $HCl_{(aq)}$
  - $HBr_{(aq)}$
  - Hydroiodic acid
  - Hydrosulfuric acid

  *all –ide anions follow the hydro_____ic acid formula even if they are **not** binary*

- $HCN_{(aq)}$ – hydrocyanic acid (cyanide ion)

Oxyacids

Oxyacids – compounds formed when hydrogen combines with polyatomic ions that contain oxygen

Oxyacid Nomenclature

- An oxyacid is the combination of hydrogen (+) and a polyatomic anion containing oxygen (-) in aqueous (dissolved) conditions
- (root)ate ions become (root)ic acids
- (root)ite ions become (root)ous acids

- $HNO_{3(aq)}$
- $H_2SO_{3(aq)}$
- $H_3PO_{4(aq)}$
- Acetic acid.
- Carbonic acid
- Nitrous acid

Hand-out

O. Molecular Compounds

Covalent bond – a shared pair of electrons held between two nonmetal atoms that hold the atom together in a molecule

Diatomic Molecules – Six from Seven plus One is Seven (H_2 O_2 F_2 Br_2 I_2 N_2 Cl_2)

Writing Formulas for Molecular Compounds Using Combining Capacities

Combining Capacity – is a measure of the number of covalent bonds that a nonmetal will need to form a stable molecule

4	3	2	1
			Hydrogen
Carbon	Nitrogen	Oxygen	Fluorine
Silicon	Phosphorus	Sulfur	Chlorine
	Arsenic	Selenium	Bromine
			Iodine

Rule 1: Write the Symbols with the far left element from the table on the left

Rule 2: Place the Combining Capacities above each symbol

Rule 3: Choose the number of atoms needed to make the combining capacities equal

Rule 4: Use the number of atoms as subscripts (as usual do not write 1's)

carbon and oxygen

phosphorus and sulfur

Naming Molecular Compounds

Molecular Compounds use prefixes to provide the number of the atoms in a formula.

Prefix	**Number**
Mono-	1
Di-	2
Tri-	3
Tetra-	4
Penta-	5
Hexa-	6
Hepta-	7
Octa-	8
Nona-	9
Deca-	10

Mono- is only used in special circumstance where a compound can have one or two oxygens

Along with prefixes molecular compounds also drop the ending of the last element named and add -ide

Example:

PBr_5

CO

CO_2

Writing Formulas for Molecular Compounds

Given the name simply write the symbols with subscripts given by the prefixes.

Triphosphorus pentoxide

Dinitrogen trisulfide

P. Molecular Compounds – Organics / Hydrocarbons

Organic compounds contain non-metals but do not have to be binary. (they almost always contain Hydrogen and Carbons)
They always contain carbons as basic building blocks and the number of carbons determines the hydrocarbons name.

Number of carbons (n)	Parent name
1	meth-
2	eth-
3	prop-
4	but-
5	pent-
6	hex-
7	hept-
8	oct-
9	non-
10	dec-

The compounds formulas or name can be derived from the name or the number of carbons…

Alkanes (C_nH_{2n+2}) ethane heptane

Alcohols ($C_nH_{2n+1}OH$) ethanol heptanol

Assignment P. 201 - 204 #1 – 9
P. 205 – 207 # 1 - 5
Blacklinemaster 5.11

II. Chemical Reactions

A. <u>Word Equations</u>

Word Equation – one way of representing a chemical reaction: it tells what reacts and what is produced.

all the reactants → all the products

Example:

iron + oxygen → iron (III) oxide

copper + silver nitrate → silver + copper (II) nitrate

B. <u>Conservation of Mass</u>

The Law of Conservation of Mass – in a chemical reaction the total mass of the reactants is always equal to the total mass of the products

How to Count Atoms Review

1. The **symbol** of an element represents one atom of that element

Ca =

2. A **subscript** is a number written to the **lower right** corner **behind the symbol** of the element. If there is more than one atom of the element in the molecule, then a subscript is used to indicate the number of atoms

N_2 =

3. A subscript outside of a bracket multiples all the elements inside the brackets

$Ba_3(PO_4)_2$ =

4. A coefficient is a number written in front of an element or compound that indicates the number of atoms or molecules. (Multiplies the number of atoms)

$\underline{2}H_2O$ =

$\underline{3}FeSO_4$ =

$\underline{4}Cu(NO_3)_2$ =

Assignment P. 218 - 219 #1 - 4
Assignment P. 222 - 223 #1 - 7
Hand-out

C. Balancing Chemical Equations

Skeleton Equation – a representation of a chemical reaction in which the formulas of the reactants are connected to the formulas of the products by an arrow

Procedure for Balancing Chemical Equations

Step1: Write the word equation

Step 2: Write the skeleton equation (Check for Diatomics: HOFBrINCl)

Step 3: Count the number of each type of atom/polyatomic in the reactants and products

Step 4: Multiply each of the formulas by the appropriate coefficients to balance the number of atoms.

Example:

Iron + oxygen → magnetic iron oxide

magnesium + nitric acid → hydrogen + magnesium nitrate

Assignment P. 226 - 229 #1 – 4
Blackline Master 6.5c
Hand-out

D. <u>Combustion Reactions</u>

Hydrocarbon + oxygen → carbon dioxide + water

Balancing

1. Balance Carbons
2. Balance Hydrogen
3. Balance oxygen

Butane + oxygen →

Ethanol + oxygen →

E. Synthesis Reactions

A + B → AB

Example

Hydrogen + oxygen →

Carbon dioxide + water →

Sodium oxide + water →

F. <u>Decomposition Reactions</u>

AB → A + B

Example:

Nitrogen triiodide →

Calcium carbonate →

Assignment P. 230 - 232 # 1 - 8
Assignment P. 233 - 235 1 - 6

G. Single Displacement Reactions

X + AB → XB + A

Cations replace cations and anions replace anions

Example:

Magnesium + silver nitrate →

H. Double Displacement Reactions

AB + XY → AY + XB

Cations are always written first.

Example:

Lead (II) nitrate + potassium iodide →

Assignment P. 240 - 241 #1 - 3

III. Rates of Reaction

There are four factors that affect the rate of a reaction:

1. Temperature
2. Concentration
3. Surface Area
4. Catalysts

Collision Theory

The rate of a chemical reaction is affected by the number of collisions of reactant molecules

1. Temperature

- As temperature increases the average speed of the molecules increases
- An increase in temperature makes the molecules collide more often and more effectively

2. Concentration

- Concentration is how much solute is in a solvent
- Increase concentration increases the rate of a reaction
- More molecules are packed into a smaller space so they are more likely to collide

3. Surface Area

- Surface area is the amount of area that is able to react.
- Reactions occur more quickly as the number of collisions increase with increased surface area the number of collisions increases

4. Catalysts

- A catalyst is a substance that increases the rate of a chemical reaction without being used in the reaction.

Read p. 260 – 264
Assignment p. 264 # 1 – 10 (omit #6)

IV. Endothermic and Exothermic Reactions

Reactions that release energy are said to be exothermic

Exothermic reactions feel warm because they release heat (energy)

Reactions that absorb heat are said to be endothermic

Endothermic reactions feel cool because they absorb heat (energy) from the surroundings

V. Acids and Bases

Properties

Acids are sour-tasting, water soluble substances that are found in many common Products

Acids always contain the hydrogen ion (H^+)

Bases are bitter, water soluble substances that feel slippery when in solution (alkaline)

Bases generally contain the hydroxide ion (OH^-) or react to produce a hydroxide

Indicators

An indicator is a substance which turns different colours ina acids and bases

The pH Scale

pH – chemists use a pH scale to represent how acidic or basic a solution is

The pH scale is logarithmic which means each increase is 10 fold

pH 3 is ten times more acidic than pH 4

a neutral solution has a pH of 7

An acidic solution has a pH < 7

A basic solution has a pH > 7

Elements and Oxides

Simple synthesis reaction

Metal + oxygen → metal oxide

Calcium + oxygen → calcium oxide

Complex synthesis reactions

Metal oxide + water → base (metal hydroxide)

Calcium oxide + water → calcium hydroxide

Simple synthesis reaction

Nonmetal + oxygen → nonmetal oxide

Carbon + oxygen → carbon dioxide

Complex synthesis reactions

Nonmetal oxide + water → acid (hydrogen and polyatomic)

Carbon dioxide + water → carbonic acid

Neutralization Reactions (double displacement)

Acid + Base → "salt" + water

Hydrochloric acid + sodium hydroxide → sodium chloride + water

Calcium carbonate + acetic acid → calcium acetate + water + carbon dioxide

Read p. 293 -295
Assignment p 295 #1 - 4
Read p. 296 - 299
Assignment p. 299 # 1 – 9
Read p. 305 - 307
Assignment p. 307 # 1 – 4